

CLAIMS

We claim:

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1. A normally-closed electrostatic microvalve device of multilayer form comprising:
- 5 a stationary valve plate layer, having a plurality of fluid flow orifices therethrough;
- a moveable valve plate layer, comprising a plurality of valve elements to close the fluid flow orifices of the stationary valve plate layer, one valve element able to move with a degree of independence from the remaining valve elements;
- 10 the movable valve plate layer arranged for deflection under an applied electrostatic force from a normal closed position, in which each of said fluid flow orifices of the stationary valve plate layer is closed by a valve element, to an open position in which one or more of the valve elements is displaced from said stationary valve plate layer.
2. The microvalve device according to claim 1, wherein the movable valve plate layer comprises resilient flexible portions interconnecting the valve elements, enabling a degree of independent movement to each valve element.
- 15 3. The microvalve device according to claim 2, the valve elements supported within the device by resilient restoring support means.
4. The microvalve device according to claim 3, the resilient flexible portions interconnecting the valve elements and the resilient restoring support means being provided by
- 20 a thin membrane layer forming an integral part of the movable valve plate layer.
5. The microvalve device according to claim 1, including a base plate layer spaced from said stationary valve plate layer, having at least one inlet fluid flow orifice therethrough, the base plate layer and the stationary valve plate layer defining therebetween an inlet chamber, the movable valve plate layer being disposed for movement within said inlet chamber, and
- 25 wherein the base plate layer includes a first conductive electrode element and the movable valve plate layer includes a second conductive electrode element such that application of an electrical potential difference between the respective electrode elements creates an electrostatic force on the moveable valve plate layer to activate the microvalve.

6. The microvalve device according to claim 5, wherein application of an electrical potential difference applied between said respective electrode elements results in greater electrostatic force on one valve element than on the remaining one or more valve elements.

7. The microvalve device according to claim 6, wherein the respective electrode elements are provided by a first and a second layer associated with, respectively, the base plate layer and the movable valve plate layer.

8. The microvalve device according to claim 7, wherein each valve element is associated with a portion of said second electrode layer and the separation between said first and said second electrode element differs for different ones of said portions when the microvalve is in its normal closed configuration.

9. The microvalve device according to claim 8, wherein said first electrode layer is disposed in a stepped configuration across the base plate layer, so to provide the differing separations between said first electrode layer and the different portions of said second electrode layer.

10. The microvalve device according to claim 5, wherein each of said first and second electrode elements is encapsulated in its respective layer.

11. The microvalve device according to claim 5, including an outlet plate layer spaced from said stationary valve plate layer, having at least one outlet fluid flow orifice therethrough, the outlet plate layer and the stationary valve plate layer defining therebetween an outlet chamber.

12. The microvalve device according to claim 1, wherein each valve element is provided with a projecting peripheral lip positioned to seal around the periphery of a corresponding orifice of the stationary valve plate layer when the microvalve is in its normal closed configuration.

13. The microvalve device according to claim 1, wherein said orifices of the stationary valve plate are substantially rectangular.

14. The microvalve device according to claim 1, said stationary valve plate layer having three spaced orifices therethrough.

15. The microvalve device according to claim 1, wherein the microvalve is fabricated using micromachining techniques.

16. The microvalve device according to claim 15, fabricated from a silicon wafer.
17. The microvalve device according to claim 15, wherein all the components of the device are integrally formed.
18. The fluid flow control apparatus including at least one microvalve device
5 according to claim 1.